Space Station Reboost Via Orbiter Towing

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The *International Space Station (ISS)* must be periodically reboosted in altitude to counter the effects of atmospheric drag. The primary means of achieving this reboost is via thruster firings of an attached Russian vehicle. Multiple Progress missions are required annually to accomplish this task.

The orbiter (Space Shuttle) could provide the same service, but due to *ISS* design, only early in the assembly sequence. Transfer of propellant from the orbiter to the *ISS* requires complex and expensive system modifications to maintain Station altitude. In contrast, towed reboost of the *ISS* by the orbiter requires minimal new hardware, little changes to existing hardware, and minimal, if any, changes to Station design. Towing would occur late in a mission, and any orbital maneuvering system (OMS) propellant reserved but not used for phasing and docking could be used for towing. Additional OMS "top-off" propellant could be flown on missions having launch performance margins that permit it, providing more propellant for towing. This Station reboost concept makes use of a derivative of the Small Expendable Deployer System (SEDS) and a noncon-ducting, expendable tow line. Orbiter towing appears feasible and attractive for *ISS* reboost during both assembly and operational phases with a nearly one-to-one savings in ISS reboost propellant for each kilogram of OMS propellant expended. Using the orbiter as a supplementary method to reboost *ISS*, particularly in its assembly phase, reduces the risk of sole dependence on Russian vehicles and provides a U.S. contingency reboost capability for relatively low cost. A precursor mission, shown in figure 182, is being studied in which the orbiter tows a significant mass such as a Progress vehicle. Validation of the towing process by such a demonstration enhances capability to perform towing of *ISS* during the assembly and operational stages.

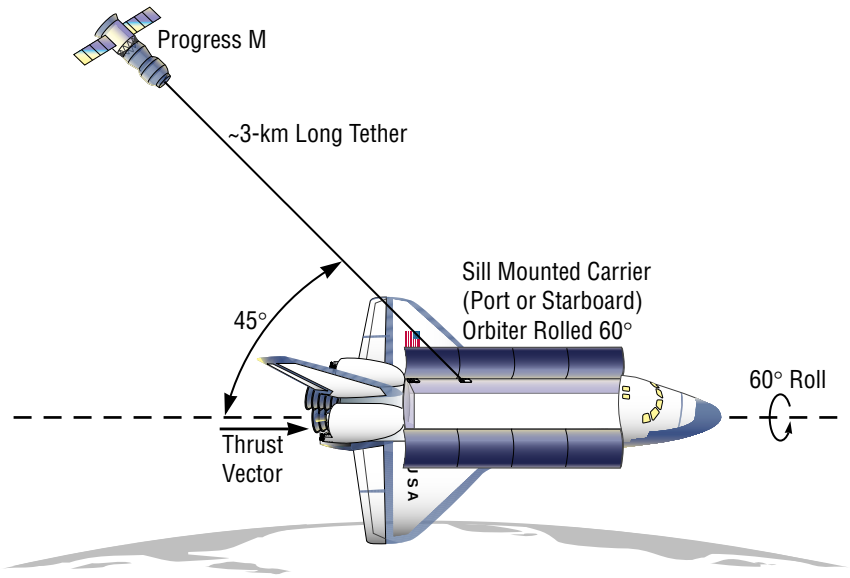

Figure 182.—Orbiter towing-thrust vector along local horizontal.

MSFC, Boeing Defense and Space Group, and Tether Applications: "Downmass Deployment/Disposal From *International Space Station* Using Tethered Systems." Contract NAS8–50000, Schedule F, TOF–007, Final Report, January 1996.

Keller, V., et. al.: "Space Station Reboost Via Orbiter Towing." Paper No. 4252, AIAA Space Programs and Technologies Conference, September 24–26, 1996, Huntsville, AL.

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Industry Involvement: The Boeing Company, Tether Applications Company; Spar

Biographical Sketch: Vernon Keller is the study manager for Space Station reboost via orbiter towing as well as for additional studies of tether applications for the *ISS*. He works in the Advanced Systems and Technology Office, within the Program Development Directorate. He has a B.S. in physics, an M.S. in physics and a Ph.D. in physics with specialty in atmospheric physics. He holds two U.S. patents. He has been employed at MSFC since 1978.

Connie Carrington is the lead systems engineer for *ISS* towing and other tether activities in Program Development. She holds a Ph.D. in spacecraft dynamics and controls, and has 23 years of engineering experience in industry, government, and academics.